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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Navy Department

EFFECTS OF VARIATIONS IN FOREBODY AND AFTERBODY DEAD RISE ON THE RESISTANCE AND SPRAY CHARACTERISTICS OF THE 22ADR CLASS VPB AIRPLANE - LANGLEY TANK MODEL 207

TED NO. NACA 2361

By

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EFFECTS OF VARIATIONS IN FOREBODY AND AFTERBODY DEAD RISE ON THE RESISTANCE AND SPRAY CHARACTERISTICS OF THE 22ADR CLASS VPB AIRPLANE - LANGLEY TANK MODEL 207

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SUMMARY

An investigation was made to determine the effects of changes in the amount and distribution of forebody and afterbody dead rise on the hydrodynamic resistance and spray characteristics of a $\frac{1}{11}$-size model of the Bureau of Aeronautics design No. 22ADR class VPB airplane. The variations in dead rise within the range investigated had no significant effects on resistance or trim, free to trim, or on resistance or trimming moment, fixed in trim. The coordinates of the peaks of the bow-spray blisters, with reference to the model, were measured at low speeds, and it was found that the model with the low dead rise at the bow had the lowest blisters. The changes in position of the maximum dead rise of the afterbody had no effect on the bow-spray blister.

INTRODUCTION

The results of resistance and spray tests of a $\frac{1}{11}$-size model of the Bureau of Aeronautics design No. 22ADR, class VPB airplane (Langley tank model 207) have been reported in reference 1. An additional investigation has been made to evaluate the effects of changes in the amount and distribution of the forebody and afterbody dead rise on the resistance and spray characteristics. This investigation was requested by the Bureau of Aeronautics, Navy Department. Five combinations of three forebodies (which differed in the amount of dead rise at the bow)

and three warped afterbodies (which differed in the position of maximum dead rise) were tested, and the results are presented in this report.

SYMBOLS

C_{Δ} load coefficient $\left(\frac{\Delta}{wb^3}\right)$

C_{Δ_o} gross-load coefficient $\left(\frac{\Delta_o}{wb^3}\right)$

C_V speed coefficient $\left(\frac{V}{\sqrt{gb}}\right)$

C_R resistance coefficient $\left(\frac{R}{wb^3}\right)$

C_M trimming-moment coefficient $\left(\frac{M}{wb^4}\right)$

C_L aerodynamic lift coefficient $\left(\frac{\text{Lift}}{\frac{1}{2}\rho SV^2}\right)$

τ trim, degrees (angle between forebody keel at the step and the water plane)

where

v maximum beam at chines, feet

Δ load on water, pounds

Δ_o gross load, pounds

V carriage speed, feet per second

g acceleration of gravity, feet per second per second

R resistance, pounds

M trimming moment, pound-feet

S area of wing, square feet

ρ density of air, slugs per cubic foot

w specific weight of water, pounds per cubic foot (63.4 for these tests; usually taken as 64 for sea water)

DESCRIPTION OF MODEL

The general arrangement of the model and curves showing the dead-rise distribution for the three forebodies and three afterbodies are shown in figure 1. The body plan is shown in figure 2. Forebody 1 and afterbody 1 form the basic model. In order to obtain the sections for the other forebodies and afterbodies, the straight portion of each section was rotated about the keel to the angle of dead rise shown in figure 1. The local beam at the chine was kept constant and the chine flare at each station was kept constant insofar as possible. The forebody and afterbody keel profile, forebody and afterbody length, step plan form and depth, and sternpost angle were left unaltered.

Preliminary tests showed that the afterbody chines did not provide a sharp enough break to prevent the flow of water over the sides of the afterbody and tail extension, and that the resistance at the hump and high speeds was excessive. Similar behavior had been observed during earlier tests of the basic model (reference 1). Chine strips similar to those used in the tests of reference 1 were therefore added to all the afterbodies. (See figs. 1 and 2.) The following combinations were tested:

Forebody	Afterbody	Model number
1 (high dead rise at bow)	1 (max. dead rise at station $17\frac{1}{2}$)	207A
2 (intermediate dead rise at bow)	1 (max. dead rise at station $17\frac{1}{2}$)	207B
3 (low dead rise at bow)	1 (max. dead rise at station $17\frac{1}{2}$)	207C
3 (low dead rise at bow)	2 (max. dead rise at station 19)	207D
3 (low dead rise at bow)	3 (max. dead rise at station 21)	207E

APPARATUS AND PROCEDURE

The tests were made in Langley tank no. 1, which is described in reference 2. The free-to-trim resistance characteristics were determined for all models to speeds beyond the hump. Fixed-trim tests of model 207E were made at sufficient trims to include zero trimming moment at hump speed and best trim from hump speed to get-away speed. Fixed-trim tests of model 207D were discontinued when the initial results showed no significant changes when compared with those of model 207E. The air-flow conditions for the present tests were slightly different from those for the original tests of model 207A (reference 1), because of changes in the towing apparatus and observation platform. The tests of the basic model, model 207A, were therefore repeated in order to make the data directly comparable.

The center of gravity for the free-to-trim tests was located 12.25 inches above the straight portion of the forebody keel and 9.52 inches forward of the point of the vee step. Moments were taken about this same point during the fixed-trim tests.

Tests were made at the normal gross load and at an arbitrarily assumed overload. The gross loads investigated and the corresponding get-away speeds are given in the following table:

Gross load			Get-away speed		
Full-size (lb)	$\frac{1}{11}$-size model (lb)	C_{Δ_o}	Full-size (ft/sec)	$\frac{1}{11}$-size model (ft/sec)	C_V
105,000 125,000	78.2 93.1	0.567 .675	129.6 141.6	38.9 42.5	6.02 6.58

The same unloading curves described in reference 1 and shown in figure 3 were used for this investigation. The unloading curves were calculated for an assumed C_L of 2.0 and a full-size wing area of 2625 square feet.

Spray photographs were taken at low speeds to determine the coordinates of the peaks of the bow-spray blisters with reference

to the model. Simultaneous bow and side photographs were taken at intervals of 2 feet per second from 6 to 16 feet per second for loads corresponding (to the nearest 0.025 C_{Δ}) to each of the unloading curves. Photographs of a grid were taken with both cameras, and all measurements of spray were corrected for parallax by means of these photographs. The results are plotted on profile and plan views of the model.

RESULTS AND DISCUSSION

The results of the free-to-trim and fixed-trim tests of model 207E are shown in figures 3 and 4. Model 207E represents the combination of forebody and afterbody with the greatest changes from the basic model (207A).

The effect of changes in dead rise at the bow on the free-to-trim characteristics is shown in figure 5 where results from the tests of models 207A, 207B, and 207C are compared. The effect of changes in the position of maximum dead rise of the warped afterbody on the free-to-trim characteristics is shown in figure 6 where results from the tests of models 207C, 207D, and 207E are compared. It can be seen from figures 5 and 6 that neither the changes in the amount of dead rise at the bow nor the changes in the position of maximum dead rise of the afterbody caused significant changes in the free-to-trim resistance or trim. The small resistance differences at high speed are not consistent and are within the accuracy of free-to-trim measurements.

In figure 7 fixed-trim data for models 207A and 207E (which have the greatest differences in forebody and afterbody dead rise) are compared at speed coefficients C_V of 4.2, 5.0, and 5.8. The resistance of model 207E appears to be slightly lower than that of model 207A, but the differences are too small to be significant. The trimming moments for the two models are the same.

The bow-spray photographs of model 207E are shown in figure 8. The effect of changes in dead rise at the bow on the height of the bow blister is shown in figure 9 where the coordinates of the peaks of the bow blisters are shown for models 207A (high dead rise at bow) and 207C (low dead rise at bow). Up to a speed coefficient of about 2.0 the model with the low dead rise at the bow had slightly lower bow blisters than the model with the high dead rise at the bow. At higher speeds the part of the forebody affected by the changes was out of the water and there were no differences in spray characteristics. The coordinates of the blister peaks for the model with intermediate dead rise at the bow, model 207B, were found to be consistently

intermediate to those for models 207A and 207C. A comparison of figures 9(a) and 9(b) shows that for both models the heights of the blisters increased with increase in gross load.

The coordinates of the blister peaks for models 207C and 207E (same forebody and greatest differences in position of maximum dead rise of afterbody) were compared and found to be identical. This was to be expected since the changes in the position of the maximum dead rise of the afterbody did not affect the trim at low speeds.

CONCLUSIONS

1. The variations in forebody and afterbody dead rise, within the range investigated, caused no significant changes in resistance or trim, free to trim, or in resistance or trimming moment, fixed in trim.

2. The model with the low dead rise at the bow had the lowest bow-spray blisters at low speeds. The changes in position of maximum dead rise of the afterbody had no effect on the bow-spray blister.

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REFERENCES

1. Woodward, David R., and Leventhal, Bernard E.: Resistance Tests of a 1/11-Size Model of the Hull of the Bureau of Aeronautics Design No. 22ADR Class VPB Airplane - Langley Tank Model 207 - TED No. NACA 2361. NACA MR No. L5H06a, Bur. Aero., 1945.

2. Truscott, Starr: The Enlarged N.A.C.A. Tank, and Some of Its Work. NACA TM No. 918, 1939.

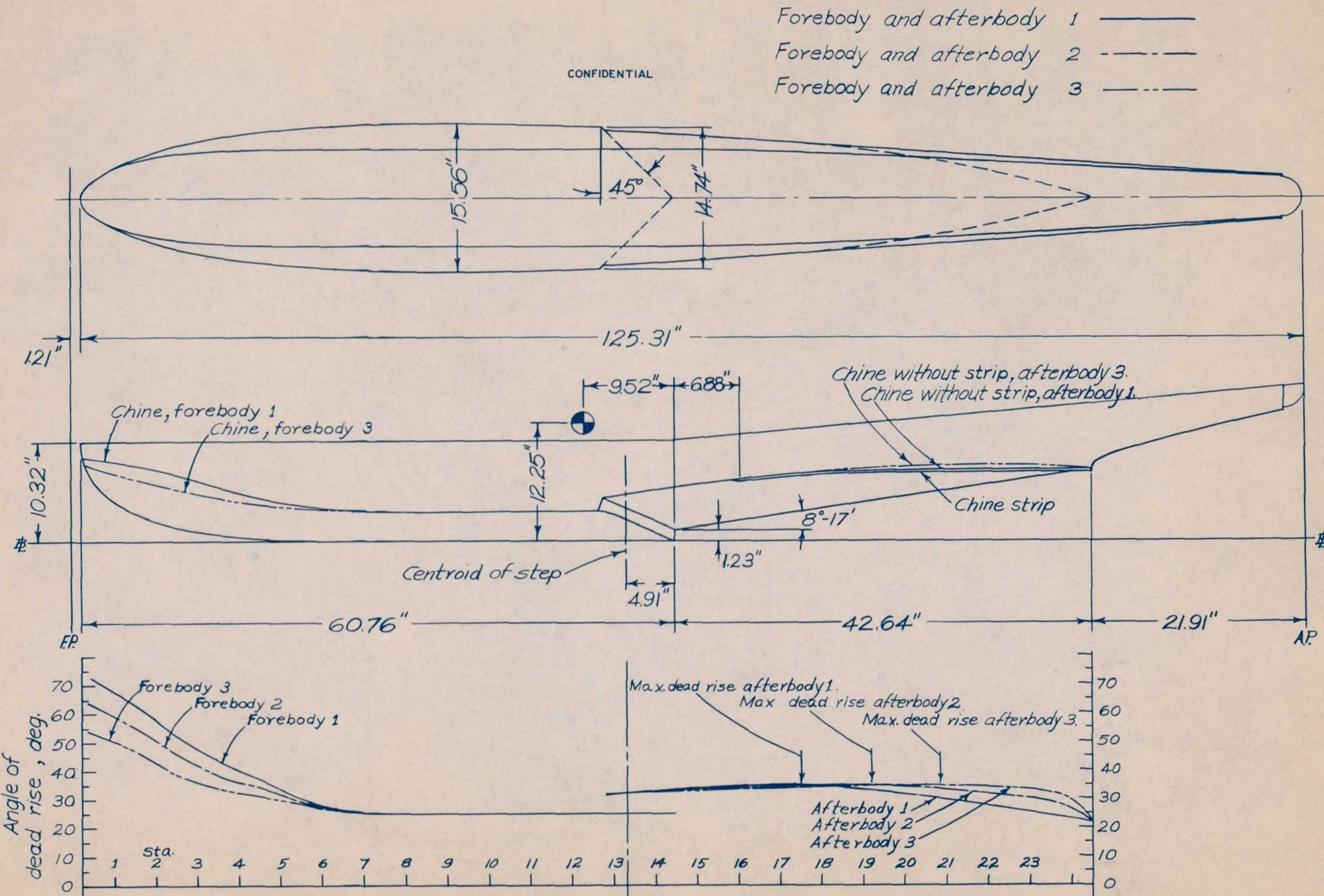

Figure 1.- Model 207 series. General arrangement.

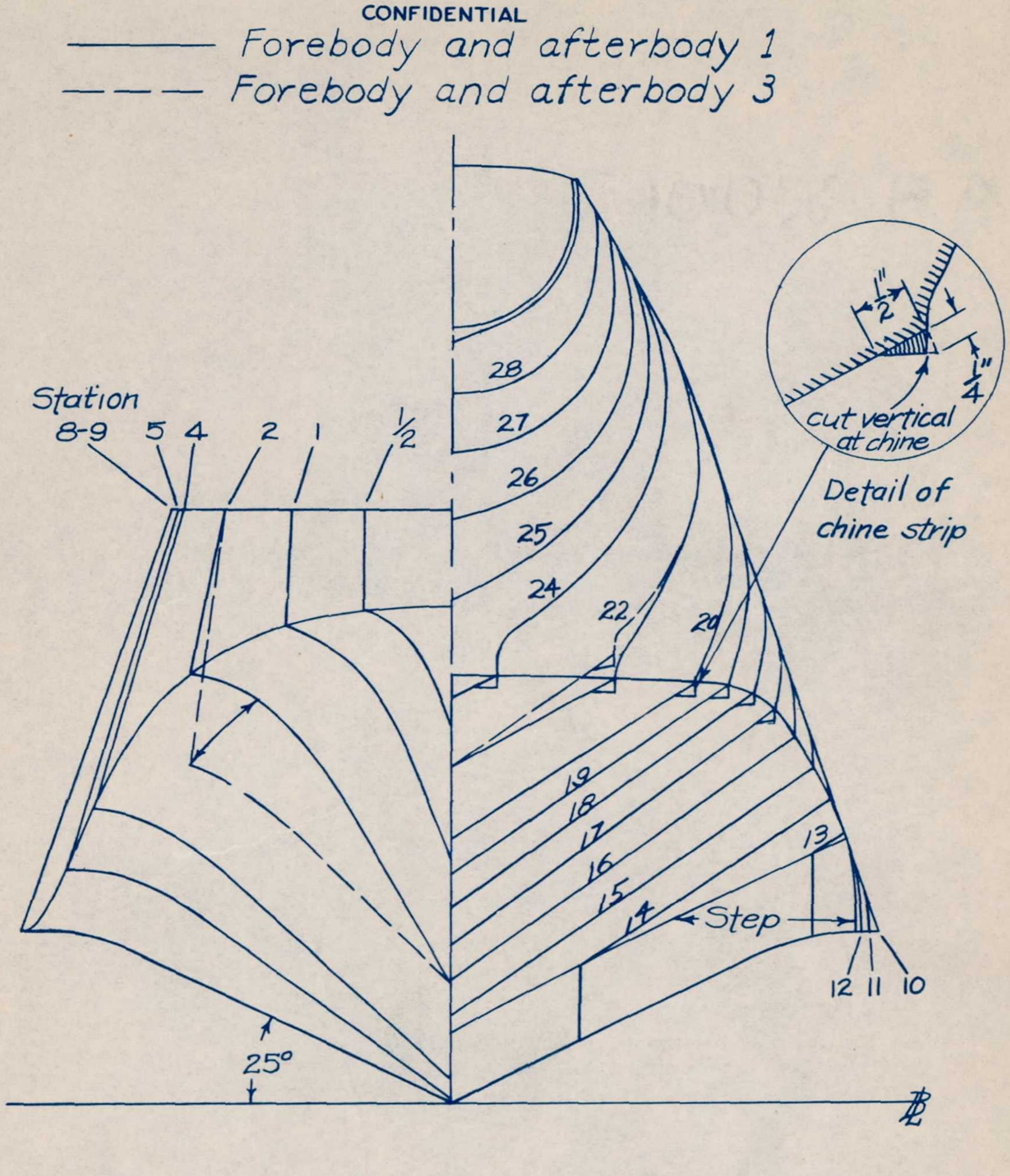

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Figure 2.-Model 207 series. Body plan.

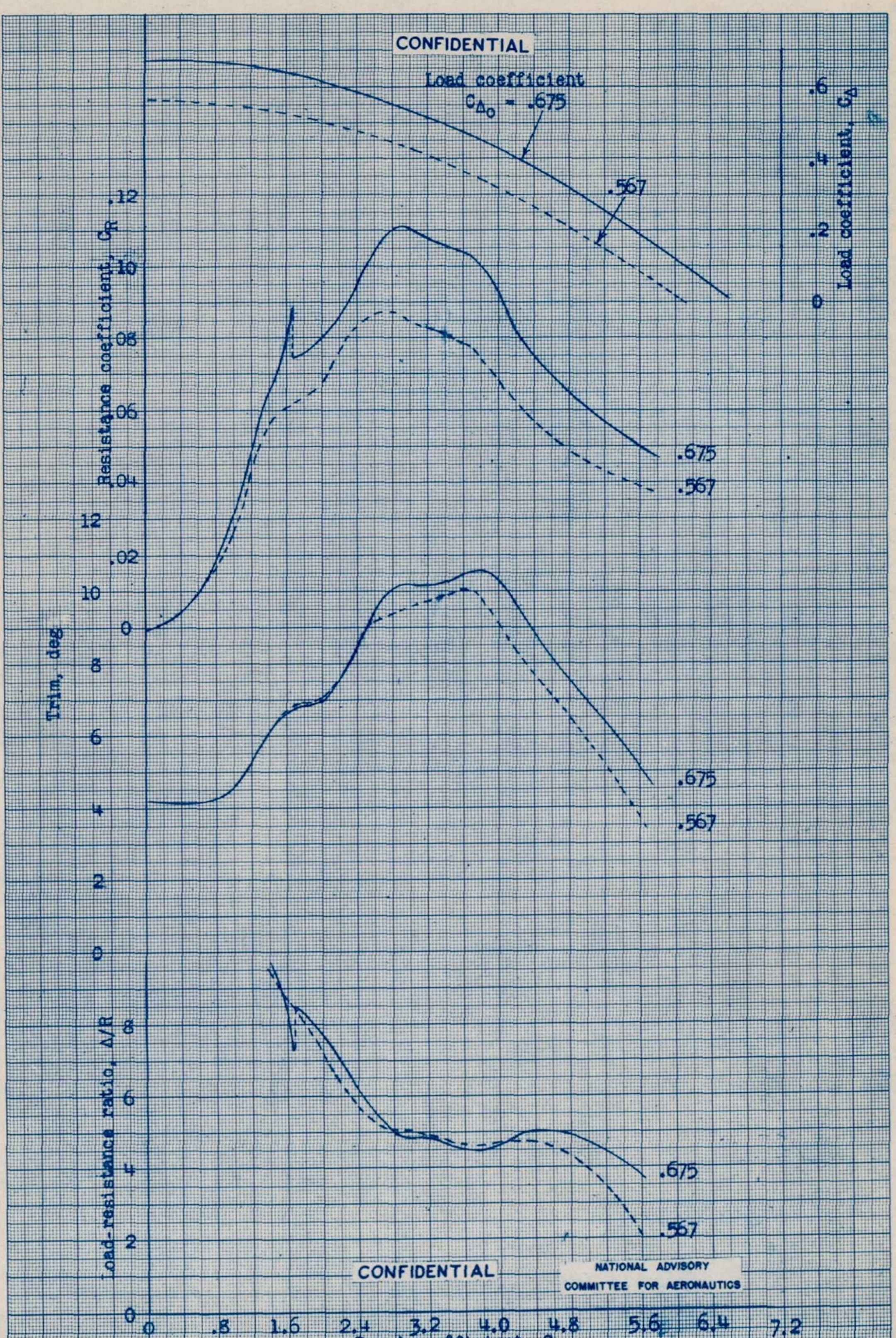
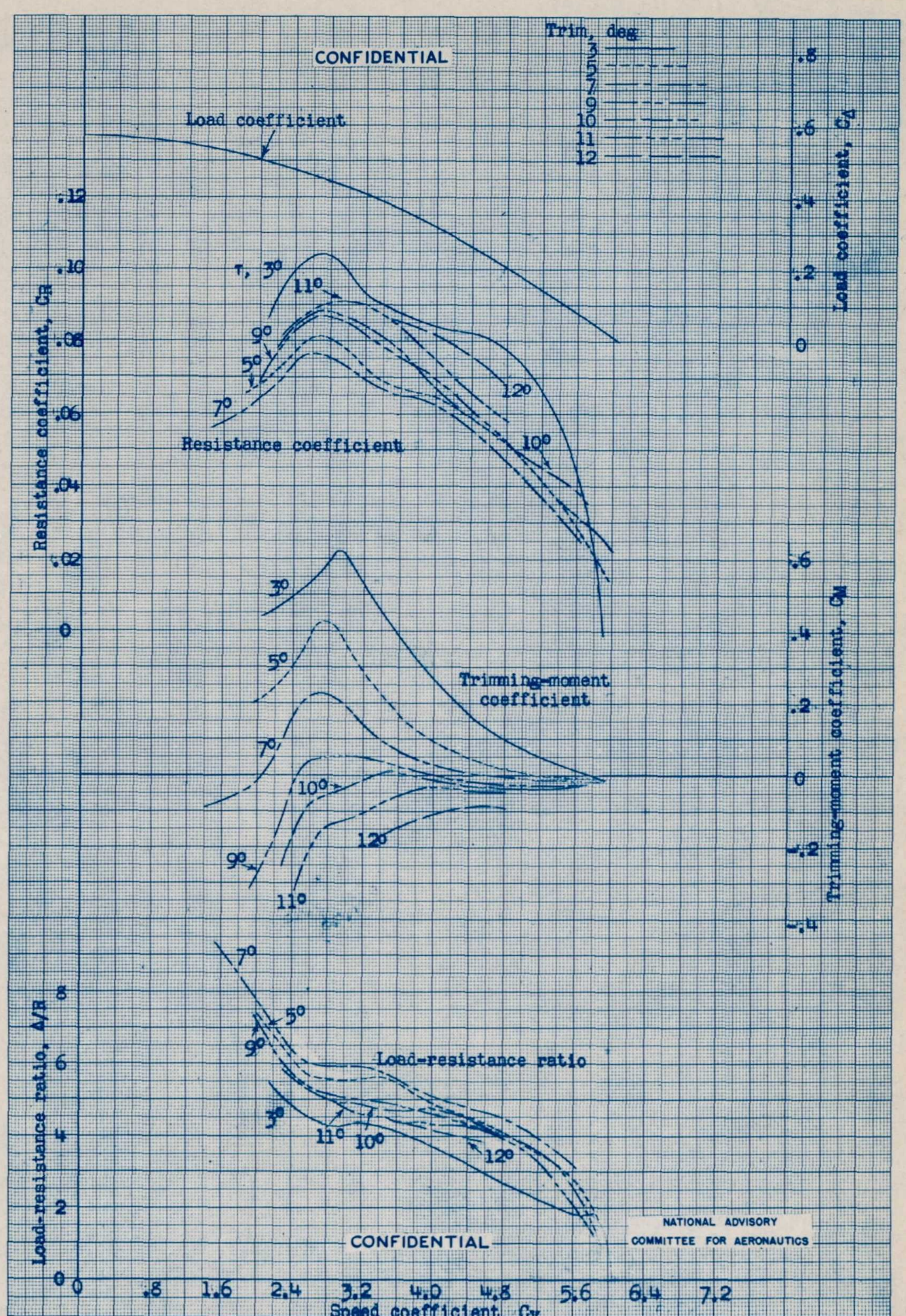


Figure 3.- Model 207E. Free-to-trim characteristics. Gross load coefficient, C_{Δ_0}, 0.675 and 0.567.



(a) Gross load coefficient, C_{Δ_0}, 0.567

Figure 4.- Model 207E. Fixed trim characteristics.

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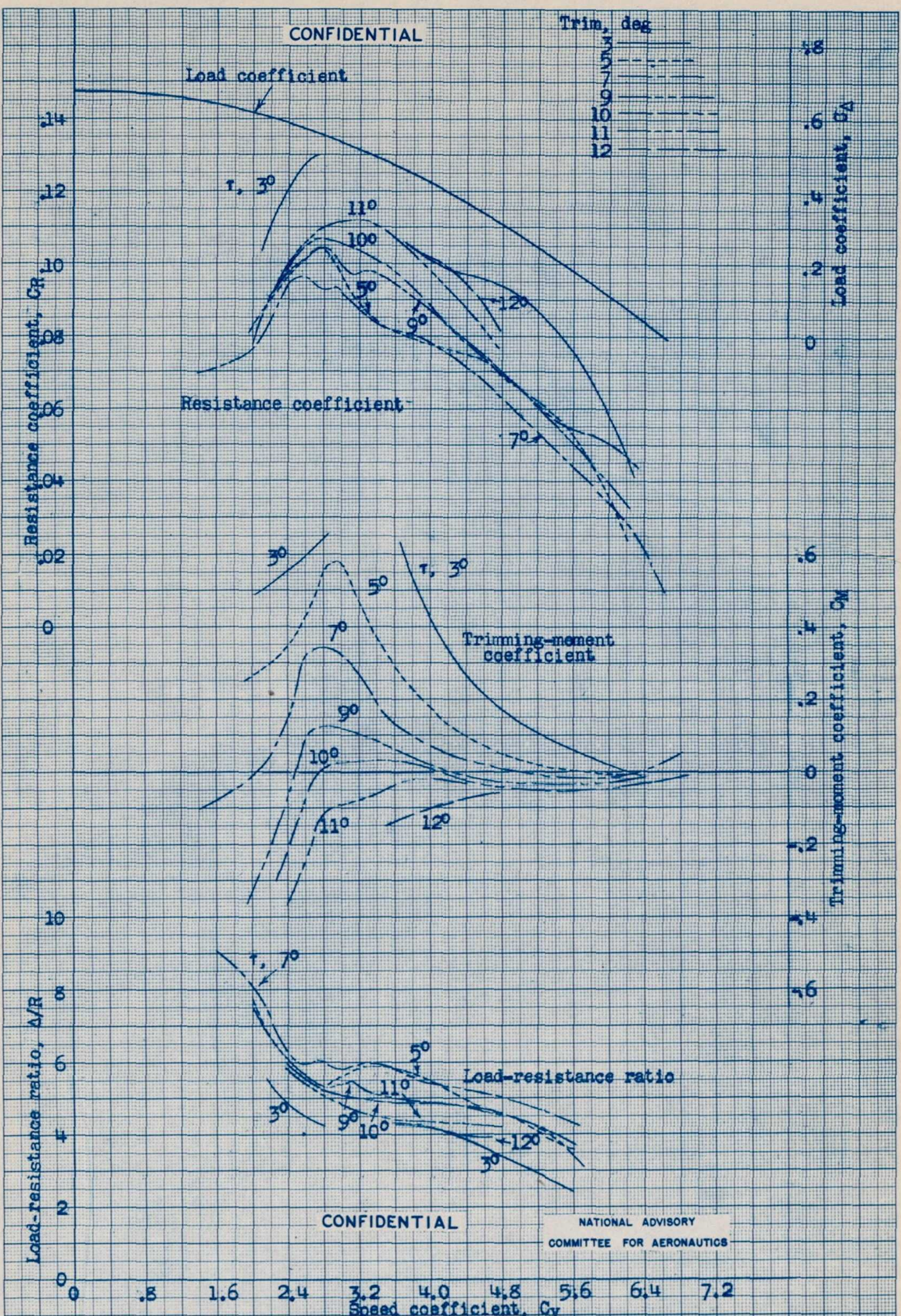

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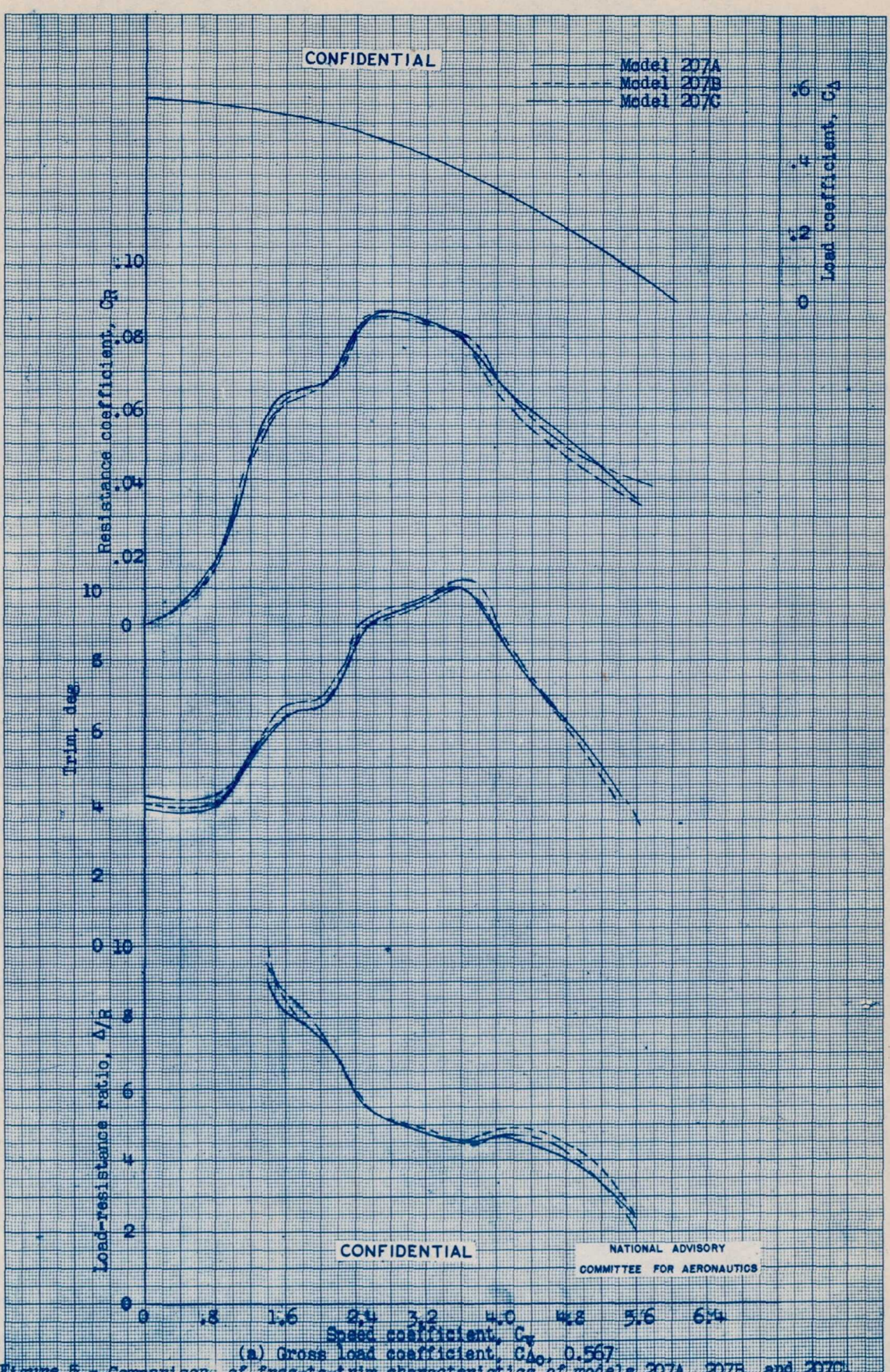
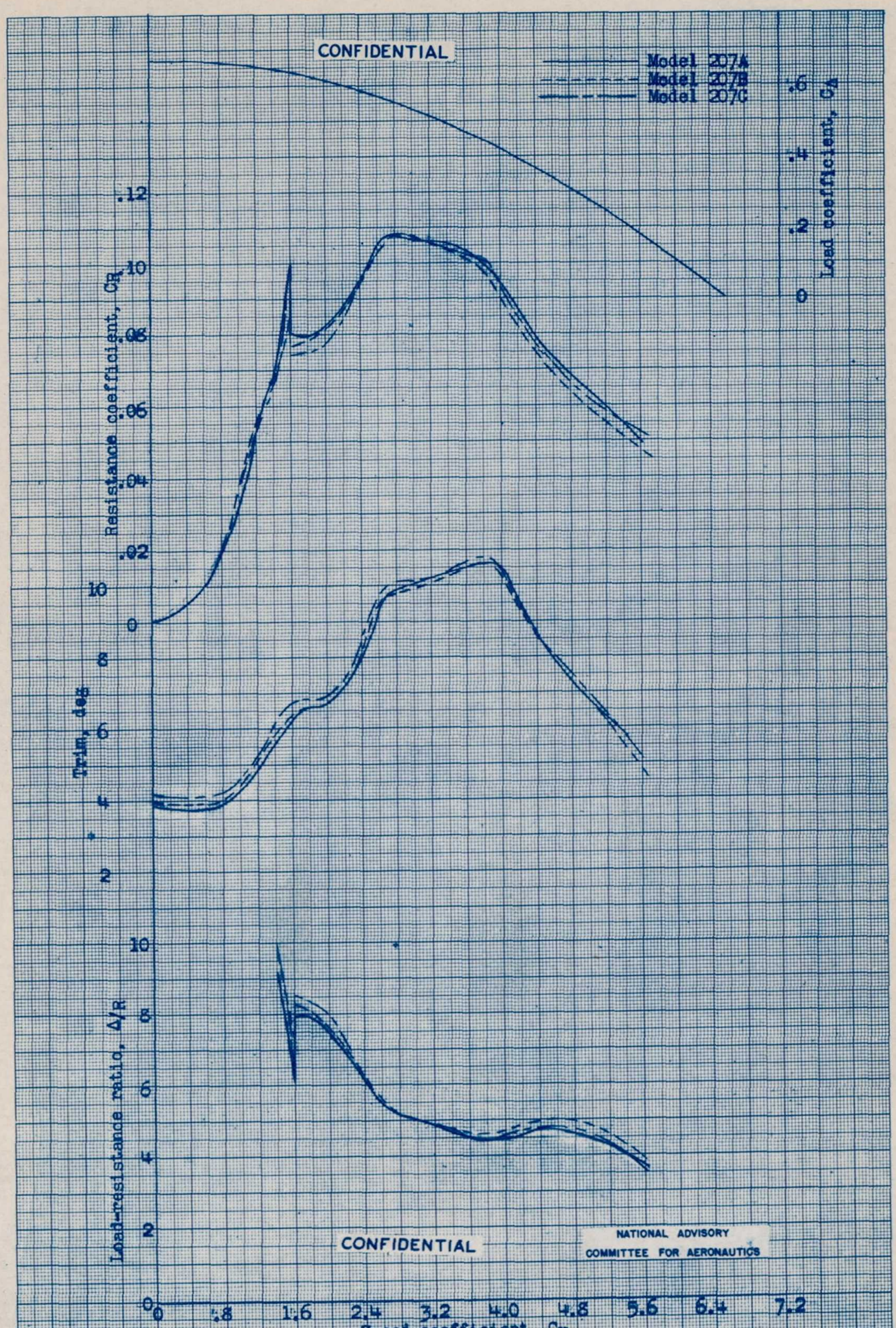
(b) Gross load coefficient, C_{Δ_0}, 0.675

Figure 4.- Concluded.



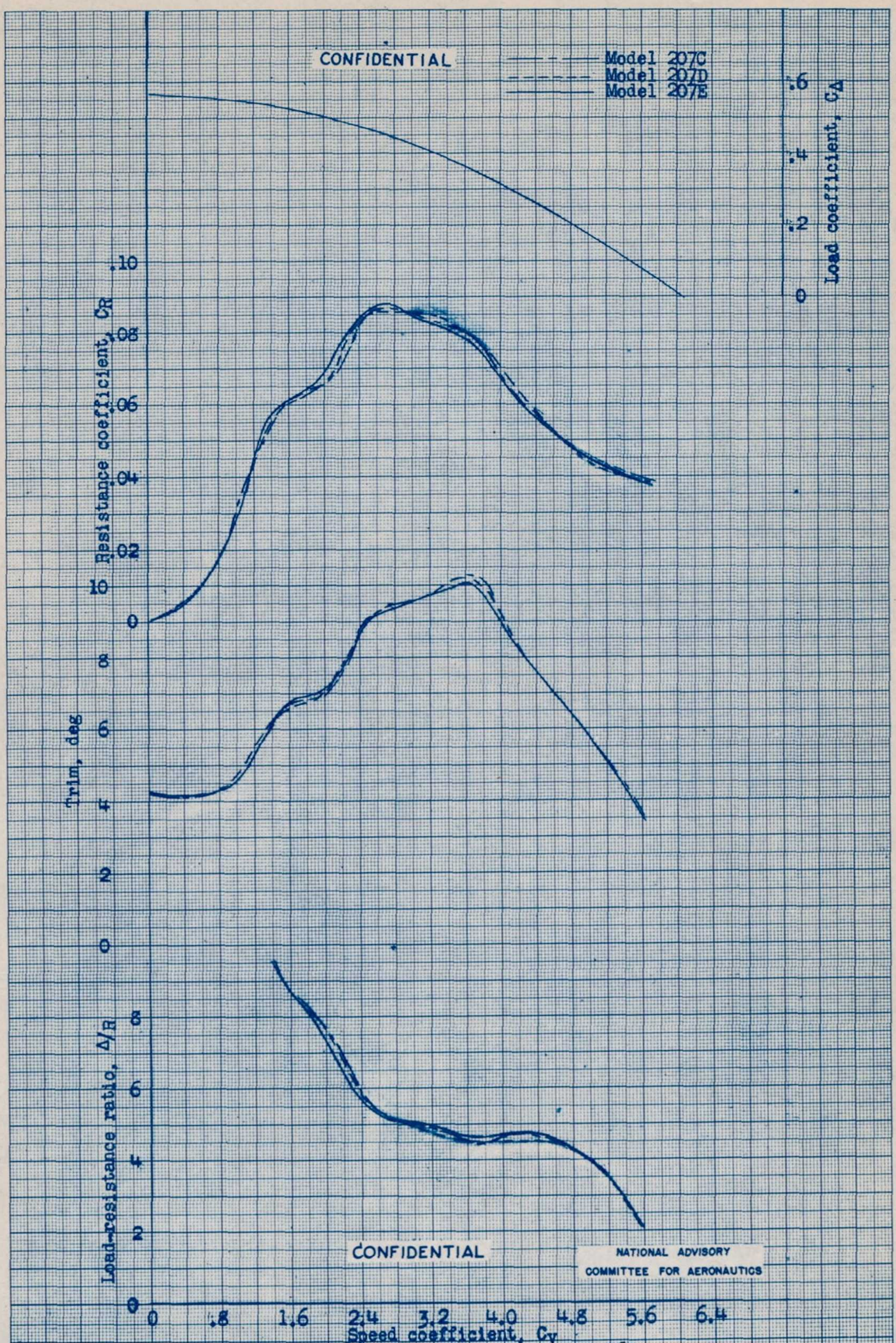
(a) Gross load coefficient, C_{Δ_0}, 0.567

Figure 5.- Comparison of free-to-trim characteristics of models 207A, 207B, and 207C.



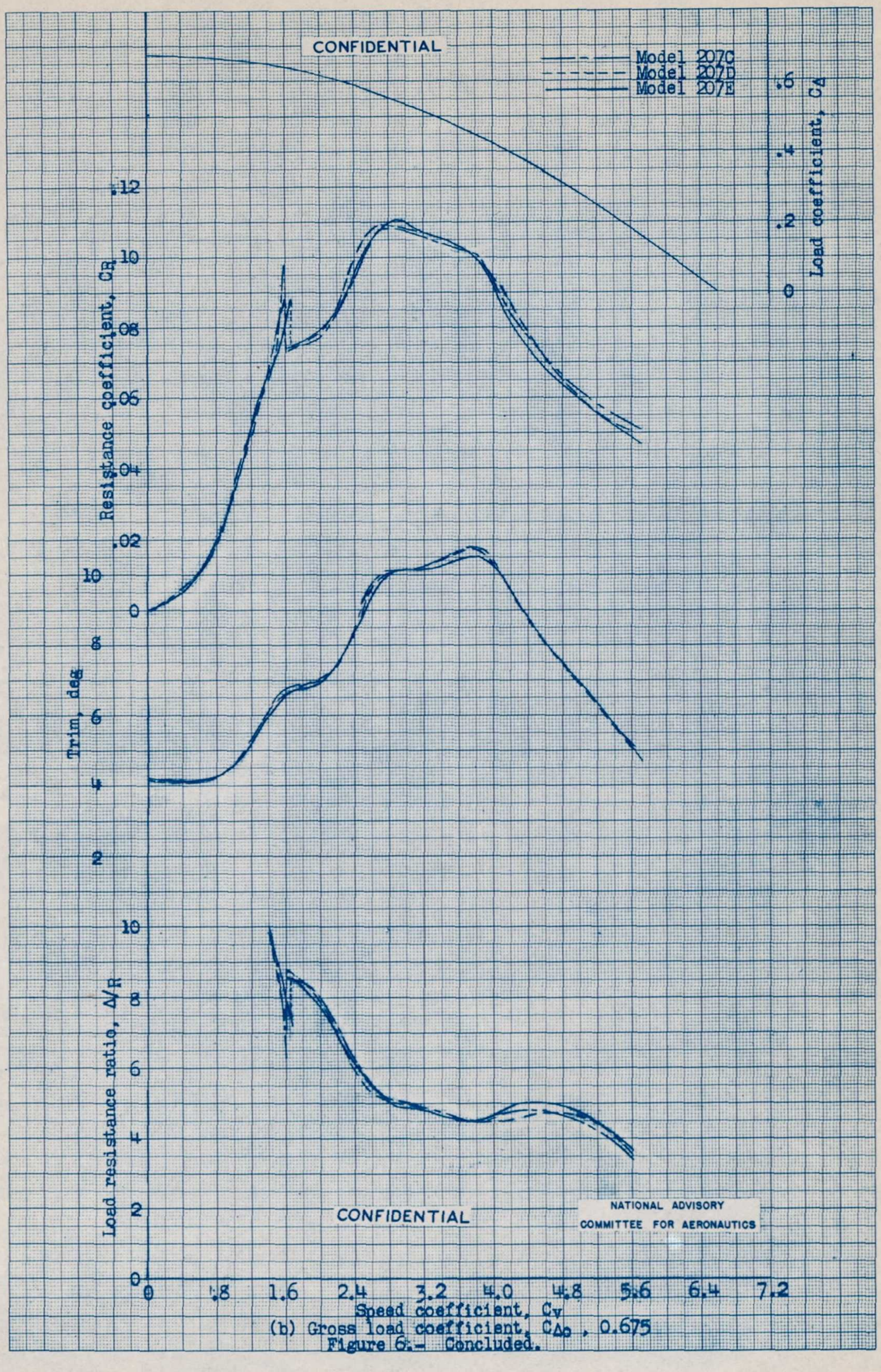
(b) Gross load coefficient, C_{Δ_0}, 0.675

Figure 5.- Concluded.



(a) Gross load coefficient, C_{Δ_0}, 0.567

Figure 6.- Comparison of free-to-trim characteristics of models 207C, 207D, and 207E.



(b) Gross load coefficient, C_{Δ_0}, 0.675

Figure 6.- Concluded.

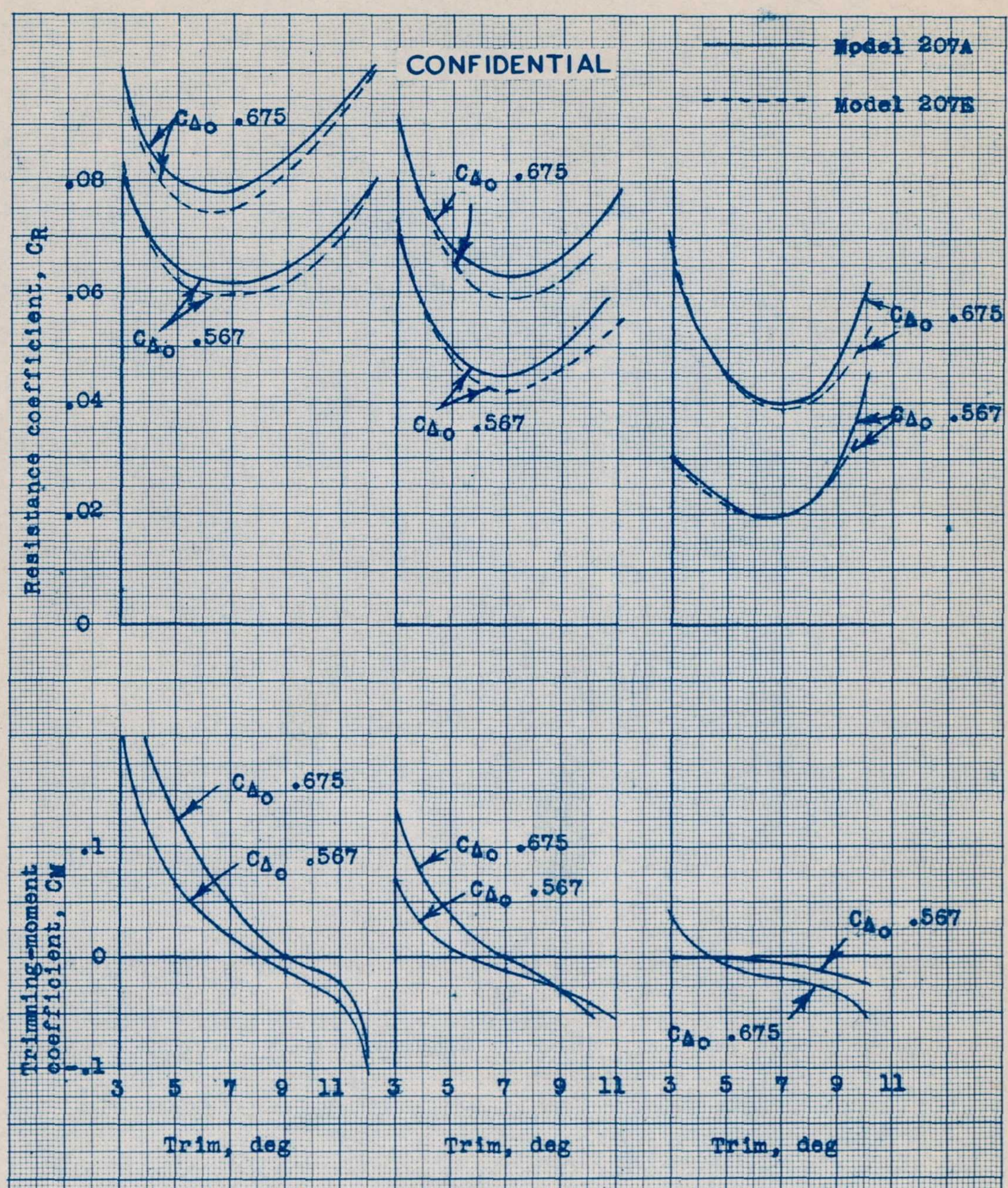
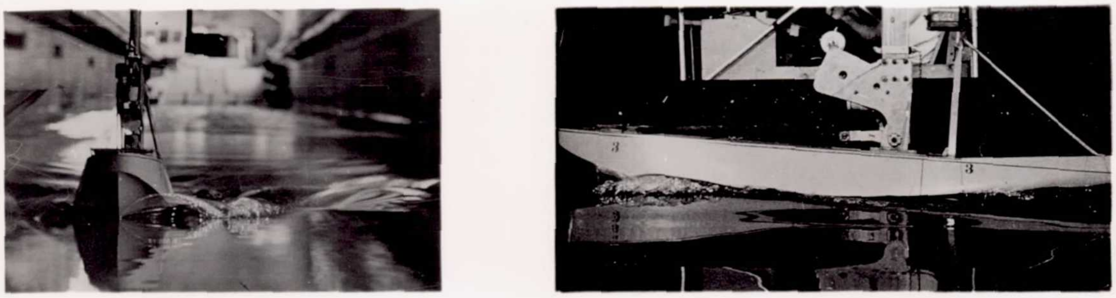
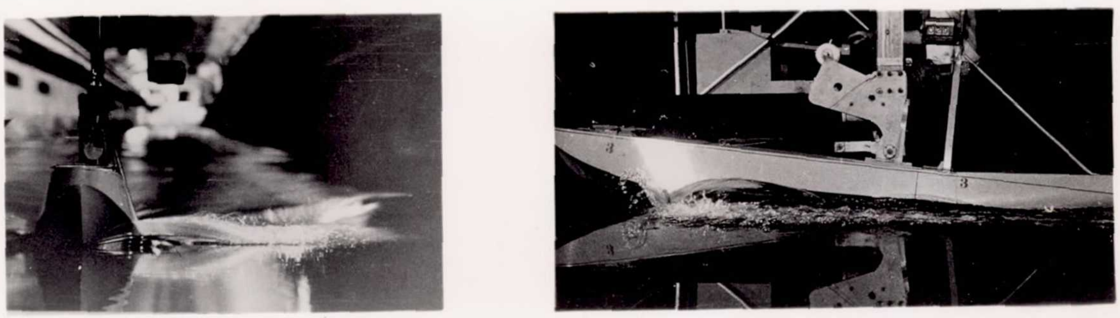


Figure 7.- Comparison of fixed-trim characteristics of models 207A and 207E for 3 planing speeds.



C_V, 0.93 C_Δ, 0.65 τ, 4.1°

C_V, 1.24 C_Δ, 0.65 τ, 5.2°



C_V, 1.55 C_Δ, 0.625 τ, 6.6°

Figure 8.- Model 207E. Bow-spray photographs, free-to-trim. C_{Δ_0}, 0.675.

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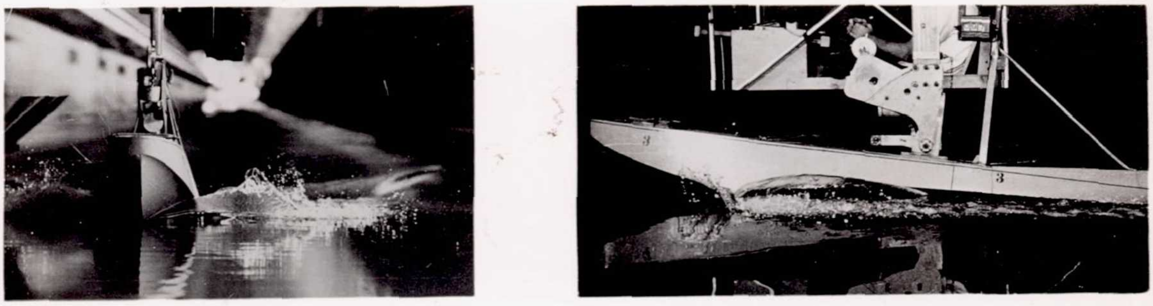
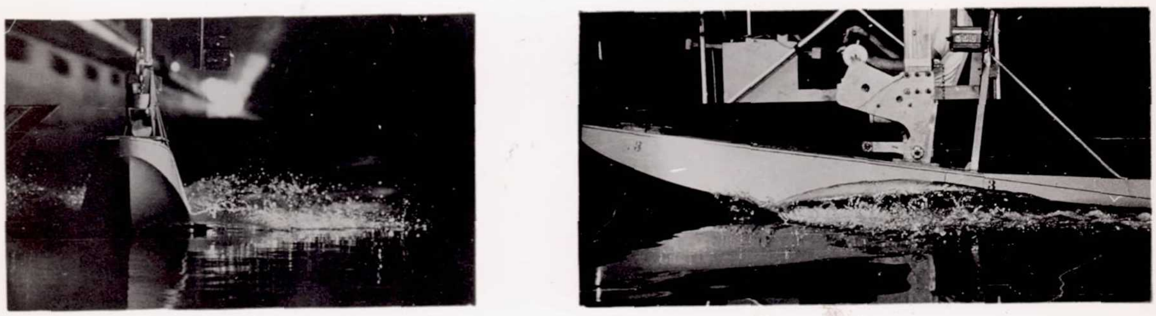
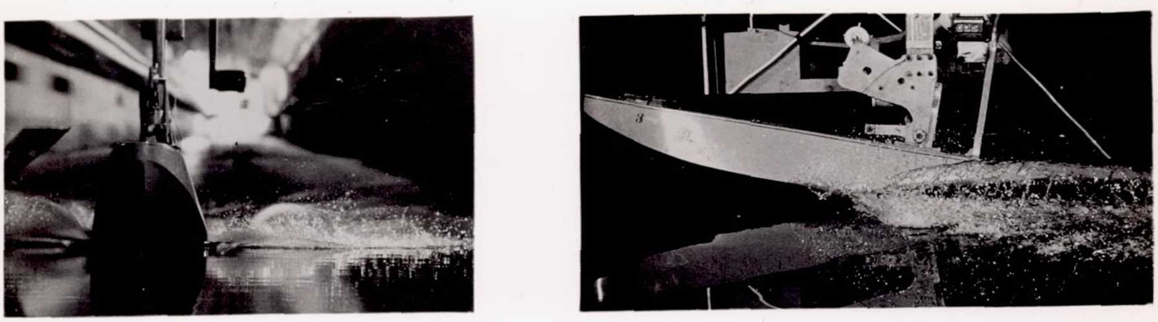


C_V, 1.86 C_Δ, 0.625 τ, 6.8°

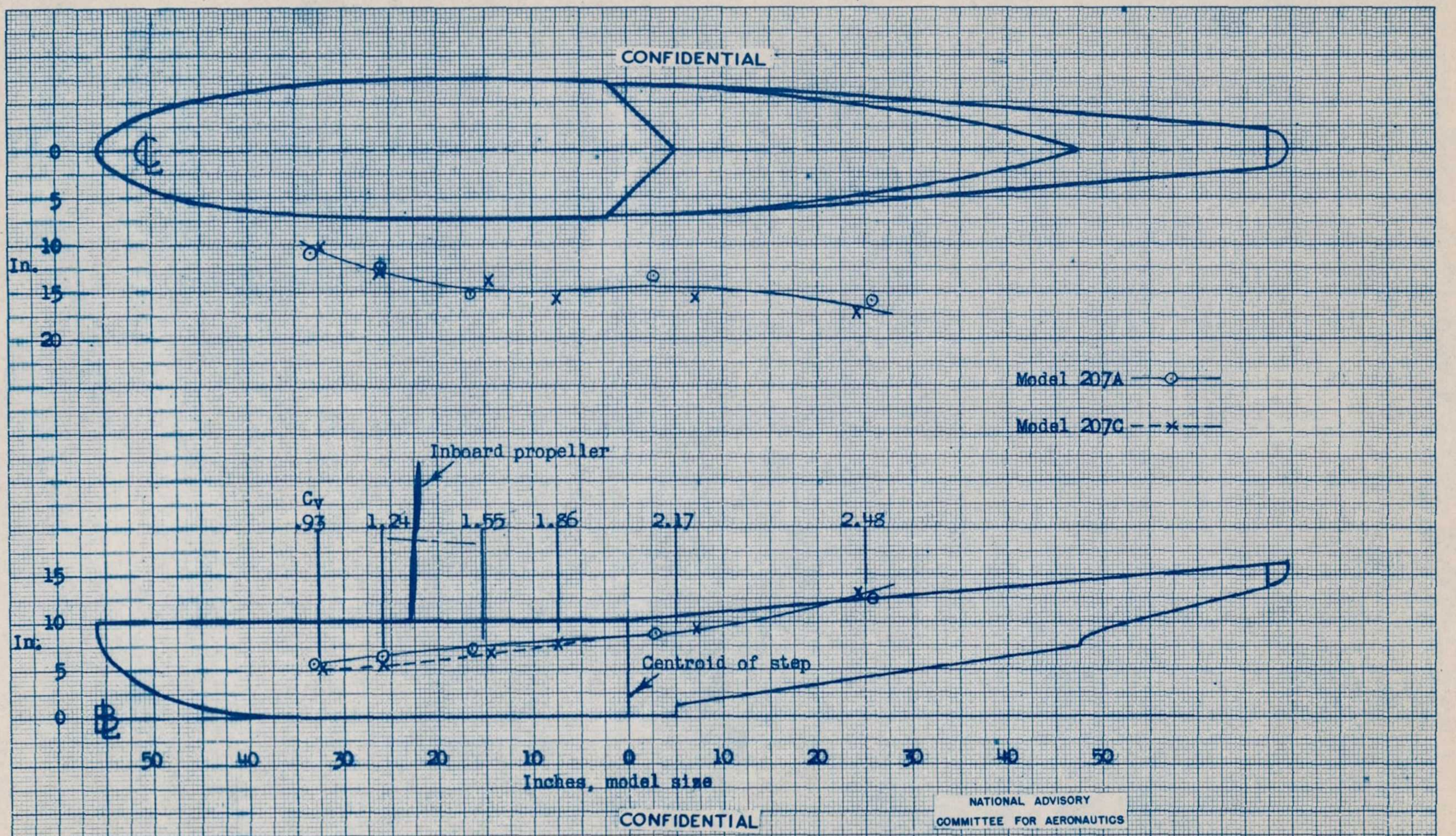


C_V, 2.17 C_Δ, 0.60 τ, 7.5°



C_V, 2.48 C_Δ, 0.575 τ, 9.2°

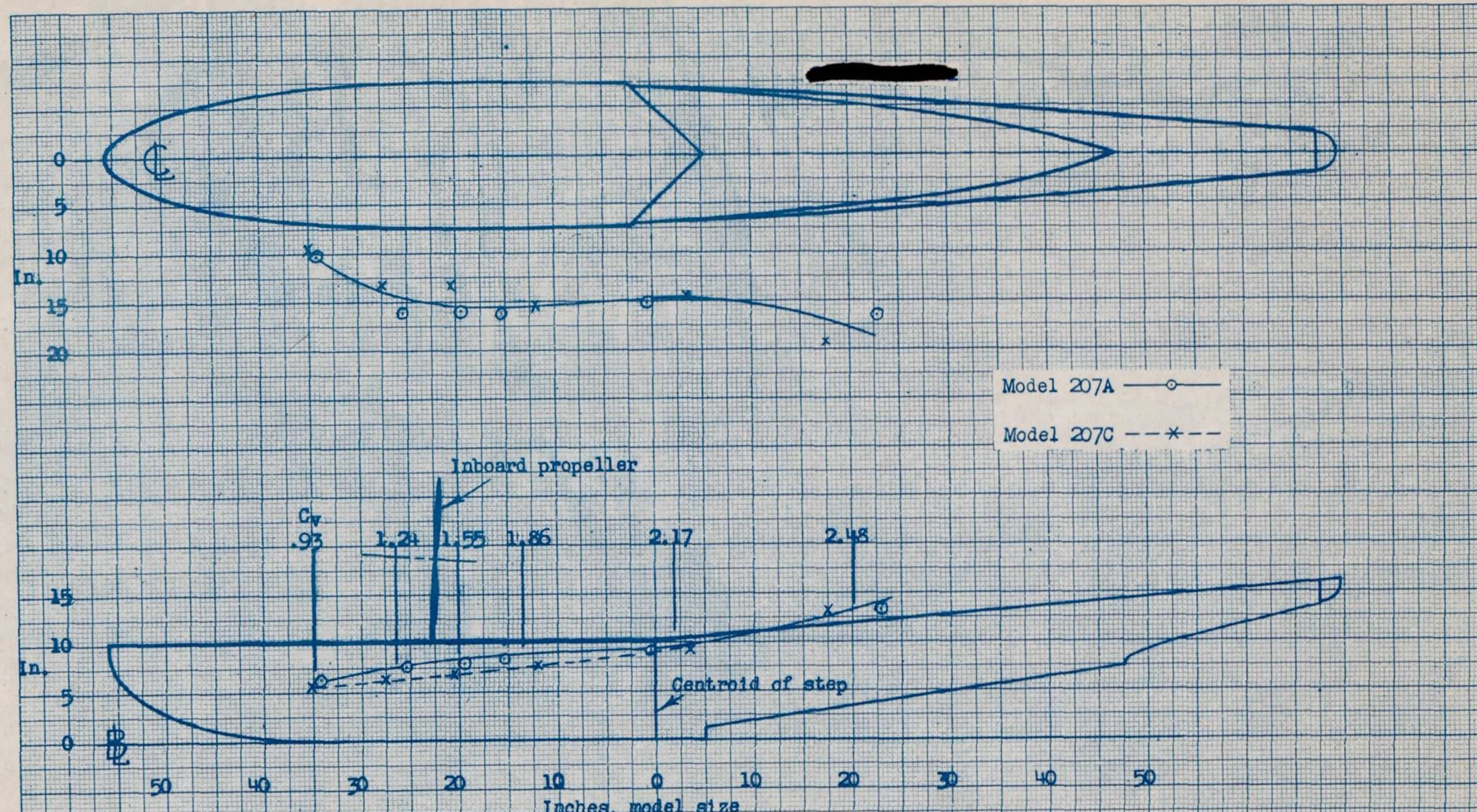
Figure 8.- Concluded. CONFIDENTIAL



(a) Gross load coefficient, C_{Δ_0}, 0.567

Figure 9.- Coordinates of peaks of bow-spray blisters for models 207A and 207C.

[redacted]



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(b) Gross load coefficient, C_{Δ_0}, 0.675

Figure 9.- Concluded.